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(54) PROCESS AND APPARATUS FOR THE MANUFACTURE OF MOULDINGS OF FOAMED PLASTICS BY A CASTING PROCESS

(71) We, DEMAG KUNSTSTOFF-TECHNIK ZWEIGNIEDERLASSUNG DER DEMAG AKTIENGESELLSCHAFT, a German Body Corporate, of D-8500 Nurnberg, Rennweg 37, Germany,

do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:–

The invention relates to a process of and apparatus for, the manufacture of mouldings of foamed plastics by a casting process, in which inserts to be embedded in the mouldings are held, during the moulding process, by holding elements which project into the mould cavity.

The manufacture of mouldings of foamed plastics, for example of rigid polyurethane foams, by casting processes has increasingly gained in importance in recent years. The manufacture of such mouldings, in contrast to the manufacture by the injection moulding process, is less expensive from the point of view of the apparatus required, since the high pressures typical of the injection moulding process are not present, and the mouldings themselves are distinguished by a relatively low specific gravity and high heat insulating capacity of the material. However, especially in the case of articles of large surface area, it is necessary to increase the shape retention of the mouldings by inserts, as a rule consisting of steel, which are embedded in the mouldings directly during their process of manufacture, that is to say round which the plastics is cast. For this purpose, the inserts must be held in the mould cavity, before introducing the plastics, or the components from which the plastics is produced, so that the inserts are embedded in the correct position of the finished moulding. This is effected either by means of holding elements which remain on the finished moulding after it is released from the mould, or by means of holding pins, which are withdrawn before release of the moulding from the mould. In the first case, a finishing process is necessary in order to remove the part of the holding elements which project beyond the surface of the moulding, whilst in the second case holes which extend up to the insert remain in the moulding. Since these holes permit access of air and moisture to the insert and can therefore cause the insert to rust, the holes are normally subsequently puttied or filled, especially in the case of articles exposed to the weather, such as window frames or the like. In both the procedures described, finishing of the finished articles is impaired by inclusions of foreign material, or touching-up marks, which remain in the surface.

According to one aspect of the present invention there is provided a process for the manufacture of mouldings of foamed plastics by a casting process, in which an insert to be embedded in a moulding is held, during the moulding process, by holding elements which project into a mould cavity, the holding elements are withdrawn from the mould cavity before the end of the moulding process, at a point in time at which the insert is sufficiently supported by the plastics foam as not to shift position by more than a permissible amount upon withdrawal of the holding elements, and the space previously occupied by the holding elements is thereafter sealed by the plastics foam.

The basic concept of the process in accordance with the present invention is thus to utilise the development of the plastics foam, taking place in the mould cavity, in two ways, namely on the one hand to employ the foam which after a certain time has already solidified somewhat to hold the insert itself, and, on the other hand, to employ the further development of the foam, up to the end of the moulding time, to close the cavities originally occupied by the holding

elements. The surface of the mouldings thus produced accordingly is of the same consistency throughout, without subsequently requiring any finishing. A further advantage is that mould release can be effected more easily than hitherto, since it is neither necessary to take account of holding elements projecting from the mouldings nor at times to draw out long conical pins.

As a rule the point in time at which the holding elements are withdrawn from the mould cavity will be so chosen that the plastics foam, which has already solidified somewhat, is sufficiently stiff to hold the insert, embedded therein, without a shift in position of the latter. However, it is entirely possible to carry out the process in such a way that the insert can still execute a certain shift in position, under the influence of gravity, should this be desired.

Because of the variables involved it is not possible to make any precise statements regarding the point in time at which the holding elements must be withdrawn from the mould cavity, in order, on the one hand, already to provide the desired holding of the insert and on the other hand to ensure that the cavities originally occupied by the holding elements will also be completely filled by foam. The reason why no general statement can be made is that this point in time will not only vary as a function of the particular plastics used, and its composition, but will also depend on the weight of the insert, the size of the moulding and the volume of the spaces occupied by the holding elements. However, this point in time can be determined simply, and rapidly, by preliminary experiments.

As a rule it will be possible so to choose the point in time at which the holding elements are retracted that all of them can be retracted simultaneously. However it is of course conceivable, if the spaces occupied by the holding elements are of differing volume, to retract those holding elements which occupy the smaller spaces at a later stage. For this purpose, it is desirable to choose, from the start, the position and arrangement of the insert in the mould cavity in such a way that the holding elements which are to be retracted last are on the underside of the insert, so that the inserts are supported for a longer time against a downward movement under the influence of gravity. In this way it is possible to retract the upper holding elements already at a very early stage, if large spaces occupied by these elements required to be sealed.

Furthermore it has been found that the point in time at which retraction takes place is not particularly critical in the foaming operations encountered in practice since the development of the foam continues for a relatively long period beyond the point at which the foam has already solidified adequately to hold the inserts securely. For this reason, variations in the formulation from moulding to moulding having no significant influence on quality, or can, conversely, be dealt with by relatively slight variations in the point in time at which retraction takes place.

It is important that the speed of retraction of the holding elements should be variable in order to adapt it to different circumstances. This is because if the holding elements for a particular plastics combination are retracted too rapidly, the foam structure in the vicinity of the resulting cavity is destroyed because of the vacuum produced in the cavity. The blowing agent would cause the cells already formed to burst at the place where the holding elements had been retracted, and would form sizable blisters on the surface of the moulding.

According to another aspect of the present invention, there is provided apparatus for the manufacture of mouldings of foamed plastics, containing inserts, by casting, comprising a casting mould having a mould cavity and retractable holding elements, which can be introduced into the mould cavity, for holding an insert during the moulding process, means for moving the holding inserts relative to the mould cavity, wherein the free end faces bf the holding elements, in a position in which they are retracted from the mould cavity, are flush with the shape-imparting wall of the mould cavity, and means for controlling the speed of retraction of the holding elements.

The present invention will now be described, by way of example, with reference to the accompanying drawings, wherein:

Figure 1 shows a cross-section through a moulding with an insert; and

Figure 2 shows a schematic longitudinal section through the mould cavity of a casting mould for the manufacture of a moulding according to Figure 1.

The moulding 1 shown in figure 1, which can be, for example, a frame element for a windowframe or the like, has a steel sheet insert 2 which is embedded directly in a plastics foam body 3 of the moulding. For simplicity it will be assumed that the moulding 1 is of prismatic shape at right angles to the plane of the drawing.

Figure 2 shows schematically an apparatus by means of which the process in accordance with the invention can be carried out. This apparatus comprises a casting mould, marked 4 in its entirety, comprising mould halves 5 and 6, which form a mould caity 7. The mould carrier which carries the mould hapves 5 and 6, the closing device for actuating the mould halves and the other requisite details are not shown here, since

they are all known and are not of significance in the present context.

A feed line 8 for plastics opens out into the mould cavity 7 and is supplied from a metering unit 9 which is only indicated schematically. The metering unit 9 contains the requisite circuits, such as timers and the like, which ensure that an amount of plastics corresponding precisely to the particular conditions enters the mould cavity 7. Of course, when processing plastics foams which are formed from several components, a number of feed lines 8 which corresponds to the number of components leads from the metering unit 9 to the mould cavity 7.

In the mould cavity 7, the insert 2 of the moulding 1 which is to be manufactured is located in the position which it is to occupy in the finished moulding 1. For this purpose, the insert 2 rests on two pins 10 which project into the mould cavity 7 from below, and is pressed downwards onto these by a further pin 10. The pins pass through the mould cells in leakproof bores, as indicated schematically. They can be actuated by hydraulic piston and cylinder arrangements 11, of which only the one for the upper pin 10 will be explained in more detail.

A piston 13 which can be subjected to pressure from either side can slide in a cylinder 12 of the double-acting piston and cylinder arrangement 11, and an adjustment sleeve 15 having an internal thread is screwed onto the piston rod 14 which projects downwards. At the top, an adjustable stop screw 16 is screwed into the cylinder 12 and determines the top position of the stroke of the piston 13. The upper pin 10 is screwed into the lower end of the adjustment sleeve 15 and can thus be inserted into the mould cavity 7, and be retracted therefrom, when the piston 13 is actuated. The adjustment sleeve 15 makes it possible to adjust the lower extreme position of the pin 10.

The cylinder 12 is subjected to a pressure medium from a pump P *via* a solenoid valve 17. The position of the solenoid valve 17 is controlled, as a function of the time, by appropriate timers of the metering unit 9, as will still be explained in more detail below. Of course, the lower piston-cylinder units 11, with the corresponding pins 10, are constructed correspondingly and controlled *via* the metering unit 9.

Using the apparatus shown in Figure 2, the process in accordance with the invention takes place as follows:–

The piston and cylinder arrangements 11 are subjected to pressure medium by the pump P, *via* their particular solenoid valve 17, so that the pins 10 are in the protruding position and hold the insert 2 in the correct position in the mould cavity 7. In this position, the mould 4 is ready to have materials metered into it. Plastics is now introduced into the mould cavity 7 by the metering unit 9, normally in a programme-controlled manner. As a result, the plastics is cast around the insert 2 present in the mould cavity. The plastics components, which are intixately mixed with one another, react with one another in the mould cavity 7 to form the foam, and in doing so progressively fill the mould cavity. Of course, the spaces occupied by the pins 10 in the mould cavity 7 remain free from foam during this period. At the end of a certain reaction time, the plastics foam has consolidated to the point that it is capable, even without additional support by the pins 10, to hold the insert 2 in the mould cavity 7 in the position in which it was held by the pins 10 before starting to introduce the plastics. This time is known, for the plastics used, from preliminary experiments, and is set on a timer of the metering unit 9. After expiration of the said time, this timer reverses the solenoid valve 17 of the piston and cylinder arrangements 11 so that now the piston 13 is subjected to pressure medium by the pump P in the opposite direction and retracts until it reaches the stop screw 16. As a result, the corresponding pins 10 are retracted from the mould cavity 7 to the point that their free end faces are exactly flush with the walls of the mould cavity 7, that is to say that they serve to impart the final shape. The speed of retraction is adjusted by suitably metered supply of pressure medium to the cylinder 12. For this purpose, as indicated schematically, the pump P is controlled from the metering unit 9.

Since, at the point in time at which the pins 10 are retracted, the foaming reaction has not yet terminated, the plastics foam expands, immediately after the retraction of the pins, into the space which becomes free, and fills the latter up to the mould wall. Accordingly, at the end of the moulding time it is possible to withdraw a moulding of which the surface is of uniform character throughout.

If the pins 10 are always to be retracted at the same point in time from the mould cavity 7 by the piston and cylinder arrangements 11, the latter can be conjointly subjected to pressure medium from the pump P *via* a shared solenoid valve 17. However, if the retraction is to take place at different points in time, each piston and cylinder arrangement 11 must have a corresponding valve 17, which can then also be controlled individually by a corresponding timer of the metering unit 9. The normal rate of extraction of the pins is of the order of magnitude of 20 mm per second. However, a lower value will have to be used with sensitive foams, and this can be determined in each case by preliminary experiments.

It is conceivable, instead of selecting time-dependent controls for the start of the retraction of the pins 10, to select pressure-dependent controls, which determine the load-bearing capacity of the plastics foam in the mould cavity 7 from the pressure exerted by the foam. Furthermore, it may be desirable xo to adjust the pins 10 that the insert 2 is prestressed somewhat.

WHAT WE CLAIM IS:–

1. A process for the manufacture of mouldings of foamed plastics by a casting process, in which an insert to be embedded in a moulding is held, during the moulding process, by holding elements which project into a mould cavity, the holding elements are withdrawn from the mould cavity before the end of the moulding process, at a point in time at which the insert is sufficiently supported by the plastics foam as noh to shift position by more than a permissible amount upon withdrawal of the holding elements, and the space previously occupied by the holding elements is thereafter sealed by the plastics foam.

2. A process according to claim 1, wherein the holding elements are retracted simultaneously from the mould cavity.

3. A process according to claim 1 or 2, wherein the holding elements are retracted at constant speed.

4. A process according to any one of claims 1 to 3, wherein the point in time of the retraction is determined as a function of the pressure of the plastics foam measured in the mould cavity.

5. A process according to any one of claims 1 to 4, wherein the insert is held under prestress by the holding elements in the mould cavity.

6. Apparatus for the manufacture of mouldings of foamed plastics, containing inserts, by casting, comprising a casting mould having a mould cavity and retractable holding elements, which can be introduced into the mould cavity, for holding an insert during the moulding process, means for moving the holding inserts relative to the mould cavity, wherein the free end faces of the holding elements, in a position in which they are retracted from the mould cavity, are flush with the shape-imparting wall of the mould cavity, and means for controlling the speed of retraction of the holding elements.

7. Apparatus according to claim 6, wherein each holding element is independently controllable.

8. Apparatus according to claim 6, wherein the holding elements are operable conjointly.

9. Apparatus according to any one of claims 6 to 8, wherein a fluid actuated piston and cylinder arrangement is provided for moving an associated holding element relative to the mould cavity.

10. Apparatus according to claim 9, wherein the stroke of each piston and cylinder arrangement is adjustable by a stop.

11. Apparatus according to claim 10, wherein the stroke of each holding element is adjustable by an adjustment sleeve.

12. A process for the manufacture of mouldings of foamed plastics by a casting process, substaktially as hereinbefore described with reference to the accompanying drawings.

13. Apparatus for the manufacture of mouldings of fojmed plastics, substantially as hereinbefore described with reference to the accompanying drawings.

14. A moulding made by the process according to any one of claims 1 to 5 and 12.

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1 SHEET *This drawing is a reproduction of the Original on a reduced scale*

Fig. 2

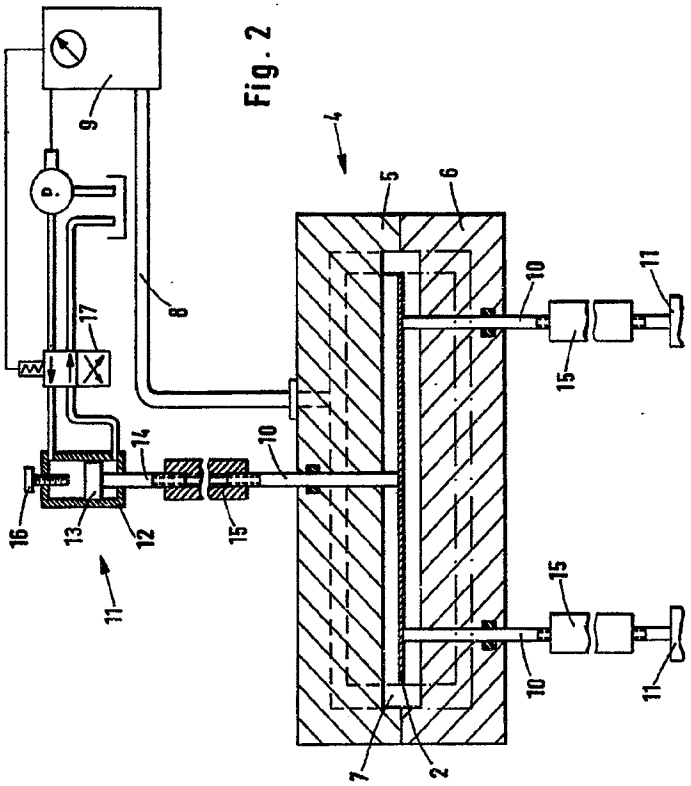

Fig. 1